Georgia Institute of Technology

ECE 6100: Spring, 2016 (Conte)

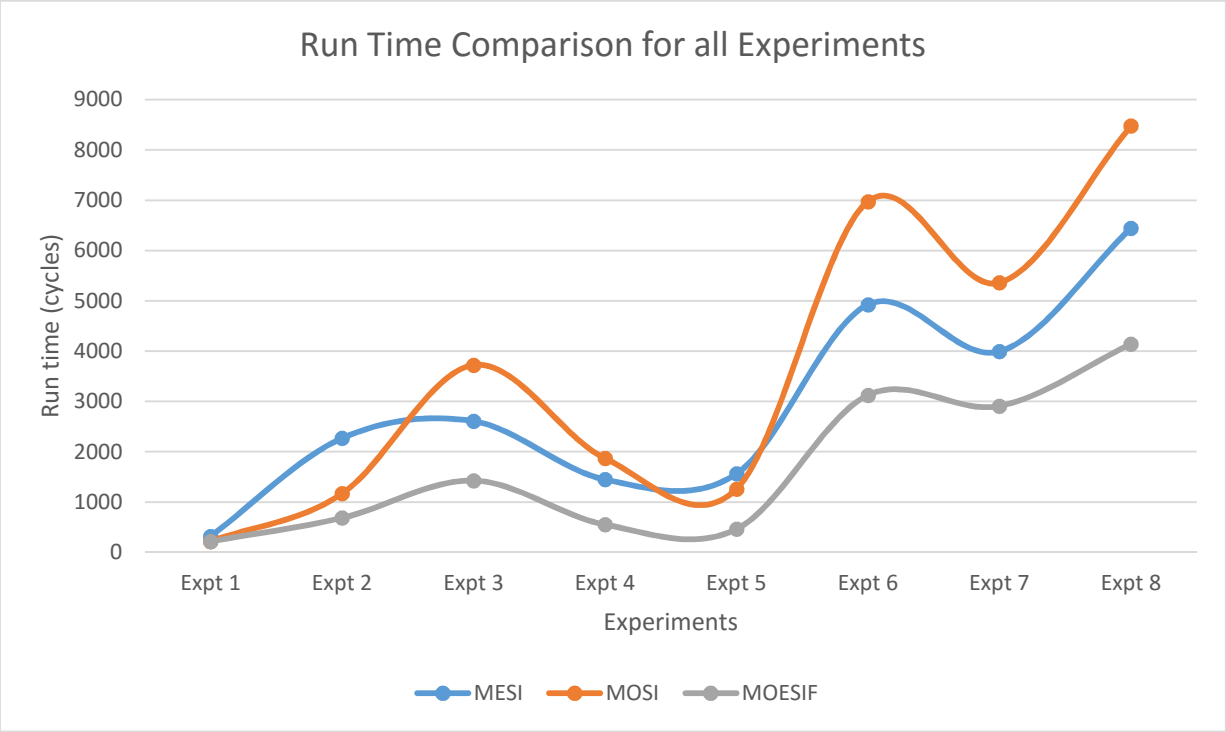
Project 3: Cache Coherence

Moumita Dey

GTID: 903099216

Email: mdey6@gatech.edu

After running all experiments, the overall run time for all the experiments for MESI, MOSI and MOESIF protocols were observed as:



It can be seen that MOESIF performed the best among all protocols for all the experiments as its execution time was the lowest.

Let us try to analyze each experiment and try to justify why this happened.

Experiment 1

In experiment 1, there are reads and writes happening to the same location. The 100 cycle difference in MESI is accounted for the fact when the cache entered an Owner state in MOSI and MOESIF and it did not in MESI, which lead to the cache putting up a request for data on the bus. As can be seen from MOSI and MOESIF statistics that, this Owner forwarded the data directly which accounts for the extra cache to cache transfer. Hence in this case, either MOSI or MOESIF is the best cache coherence protocol to use.

	MESI	MOSI	MOESIF
# cores	4	4	4
# execution cycles	317	217	217
# cache misses	7	7	7
# cache accesses	12	12	12
# silent upgrades	0	0	0
# cache to cache transfers	4	5	5

Experiment 2

In this experiment, the Forwarder state of the cache comes into picture, along with Owner and Exclusive state. As can be seen, there were more number of cache misses in MOESIF, this lead to the Forwarder sending the data to the cache requesting it directly, which leads to drastic decrease in execution cycles. As can be seen the cache to cache transfer increases dramatically as well. Thus MOESIF is the best protocol to use in this case.

	MESI	MOSI	MOESIF
# cores	4	4	4
# execution cycles	2267	1167	683
# cache misses	30	30	34
# cache accesses	104	104	104
# silent upgrades	1	0	1
# cache to cache transfers	8	19	28

Experiment 3

In this experiment, the better results of MOESIF is due to Exclusive and Forwarder state coming into picture. The traces are designed in such a way that Owner state is not reached often and hence it does not contribute much of the statistics. As MESI has Exclusive state, MESI has a better performance than MOSI. MOESIF has added advantage of both the states, hence it is better to use MOESIF in this case as well.

	MESI	MOSI	MOESIF
# cores	8	8	8
# execution cycles	2607	3723	1425
# cache misses	48	56	48
# cache accesses	200	200	200
# silent upgrades	8	0	8
# cache to cache transfers	23	20	35

Experiment 4

This case is again similar to the previous case. However, the Forwarder stage is much more dominating, that is, in the trace there are a lot of cache blocks which are shared by multiple blocks for a lot of time. Thus, Forwarder plays an important role here. Again, MOESIF is the best protocol here.

	MESI	MOSI	MOESIF
# cores	4	4	4
# execution cycles	1447	1869	551
# cache misses	19	29	19
# cache accesses	60	60	60
# silent upgrades	3	0	3
# cache to cache transfers	5	11	14

Experiment 5

Owner and Forwarder majorly lead this experiment here, with Forwarder dominating. Thus, even though MOSI has slightly better performance than MESI, with help of the Forwarder, MOESIF has a drastically better performance. Again, here MOESIF is the best protocol to use.

	MESI	MOSI	MOESIF
# cores	8	8	8
# execution cycles	1561	1261	461
# cache misses	21	21	21
# cache accesses	37	37	37
# silent upgrades	0	0	0
# cache to cache transfers	6	9	17

Experiment 6

This experiment has similar results to that of experiment 3, just that this is for more number of cores. Here too, MOESIF is a better protocol to use.

	MESI	MOSI	MOESIF
# cores	16	16	16
# execution cycles	4925	6975	3125
# cache misses	62	87	62
# cache accesses	747	747	747
# silent upgrades	25	0	25
# cache to cache transfers	15	20	33

Experiment 7

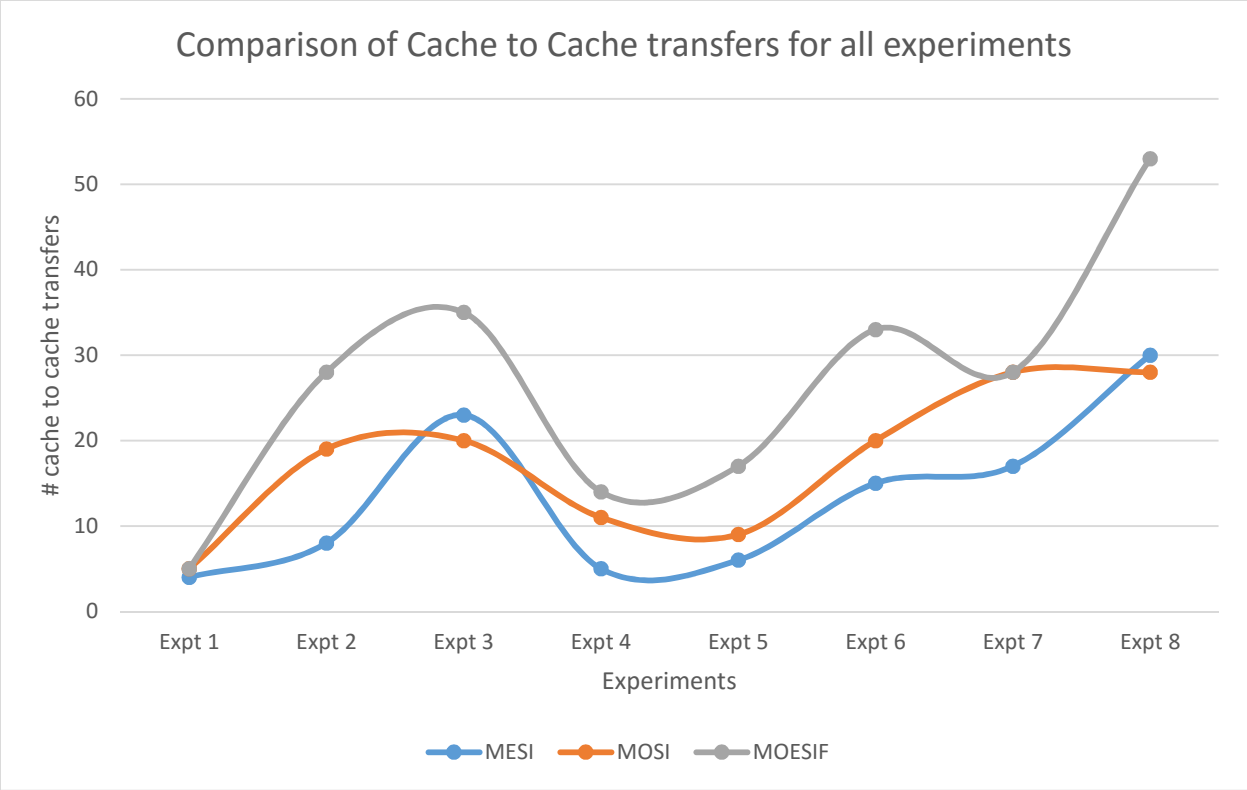
This experiment is similar to experiment 6. However, we can observe that the number of cache to cahce transfers for MOESIF is the same as that of MOSI. This means that even though we have Exclusive state, it actually doesn't help much when operating MOESIF and the cache to cache transfer taking place is majorly by the Owner. The Forwarder enhances the performance. Here too, MOESIF is a better protocol to use.

	MESI	MOSI	MOESIF
# cores	16	16	16
# execution cycles	3993	5359	2909
# cache misses	55	79	55
# cache accesses	952	952	952
# silent upgrades	24	0	24
# cache to cache transfers	17	28	28

Experiment 8

This experiment is like a balance of all the states. Thus, as Exclusive, Owner and Forwarder are given equal priorities, MOESIF is a better protocol to use here as well due to its ability to exploit all the states.

	MESI	MOSI	MOESIF
# cores	16	16	16
# execution cycles	6441	8477	4141
# cache misses	92	110	92
# cache accesses	800	800	800
# silent upgrades	19	0	19
# cache to cache transfers	30	28	53



Overall, the behavior of the execution time can be observed by looking at the total number of cache to cache transfers. More the number of cache to cache transfers, the lesser there will a penalty to go and look up a cache block from the memory. As can be seen from the comparison above, MOESIF always has the greatest number of cache to cache transfer for every experiment, which explains its lowest run time for all experiments. Hence MOESIF is the best protocol to use.